SCIENCE

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ADDRESS OF THE PRESIDENT BEFORE THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

II.

FUNCTION OF CELLS.

IT has already been stated that, when new cells arise within pre-existing cells, division of the nucleus is associated with cleavage of the cell plasm, so that it participates in the process of new cell-formation. Undoubtedly, however, its *rôle* is not limited to this function. It also plays an important part in secretion, nutrition, and the special functions discharged by the cells in the tissues and organs of which they form morphological elements.

Between 1838 and 1842 observations were made which showed that cells were constituent parts of secreting glands and mucous membranes (Schwann, Henle). In 1842 John Goodsir communicated to the Royal Society of Edinburgh a memoir on secreting structures, in which he established the principle that cells are the ultimate secreting agents; he recognized in the cells of the liver, kidney and other organs the characteristic secretion of each gland. The secretion was, he said, situated between the nucleus and the cell wall. At first he thought that, as the necleus was the reproductive organ of the cell, the secretion was formed in the interior of the cell by the agency of the cell wall; but three years later he regarded it as a product of the

nucleus. The study of the process of spermatogenesis by his brother, Harry Goodsir, in which the head of the spermatozoon was found to correspond with the nucleus of the cell in which the spermatozoon arose, gave support to the view that the nucleus played an important part in the genesis of the characteristic product of the gland cell.

The physiological activity of the cell plasm and its complex chemical constitution soon after began to be recognized. Some years before Max Schultze had published his memoirs on the characters of protoplasm, Brücke had shown that the well-known changes in tint in the skin of the Chamæleon were due to pigment granules situated in cells in the skin which were sometimes diffused throughout the cells, at others concentrated in the center. Similar observations on the skin of the frog were made in 1854 by von Wittich and Harless. The movements were regarded as due to contraction of the cell wall on its contents. In a most interesting paper on the pigmentary system in the frog, published in 1858, Lord Lister demonstrated that the pigment granules moved in the cell plasma, by forces resident within the cell itself, acting under the influence of an external stimulant, and not by a contractility of the wall. Under some conditions the pigment was attracted to the center of the cell, when the skin became pale; under other conditions the pigment was diffused throughout the body and the branches of the cell, and gave to the skin a dark color. It was also experimentally shown that a potent influence over these movements was exercised by the nervous system.

The study of the cells of glands engaged in secretion, even when the secretion is colorless, and the comparison of their appearance when secretion is going on with that seen when the cells are at rest, have shown that the cell plasm is much more granular and opaque, and contains larger particles during activity than when the cell is passive; the body of the cell swells out from an increase in the contents of its plasm, and chemical changes accompany the act of secretion. Ample evidence, therefore, is at hand to support the position taken by John Goodsir, nearly sixty years ago, that secretions are formed within cells, and lie in that part of the cell which we now say consists of the cell plasm; that each secreting cell is endowed with its own peculiar property, according to the organ in which it is situated, so that bile is formed by the cells in the liver, milk by those in the mamma, and so on.

Intimately associated with the process of secretion is that of nutrition. As the cell plasm lies at the periphery of a cell, and as it is, alike both in secretion and nutrition, brought into closest relation with the surrounding medium, from which the pabulum is derived, it is necessarily associated with nutritive activity. Its position enables it to absorb nutritive material directly from without, and in the process of growth it increases in amount by interstitial changes and additions throughout its substance, and not by mere accretions on its surface.

Hitherto I have spoken of the cell as a unit, independent of its neighbors as regards its nutrition and the other functions which it has to discharge. The question has, however, been discussed, whether in a tissue composed of cells closely packed together cell plasm may not give origin to processes or threads which are in contact or continuous with corresponding processes of adjoining cells, and that cells may therefore, to some extent, lose their individuality in the colony of which they are members. Appearances were recognized between 1863 and 1870 by Schrön and others in the deeper cells of the epidermis and of some mucous membranes which

gave sanction to this view, and it seems possible through contact or continuity of threads connecting a cell with its neighbors, that cells may exercise a direct influence on each other.

Nägeli, the botanist, as the foundation of a mechanico-physiological theory of descent, considered that in plants a network of cell plasm, named by him idioplasm, extended throughout the whole of the plant, forming its specific molecular constitution, and that growth and activity were regulated by its conditions of tension and movements (1884).

The study of the structure of plants with special reference to the presence of an intercellular network has for some years been pursued by Walter Gardiner (1882–97), who has demonstrated threads of cell plasm protruding through the walls of vegetable cells and continuous with similar threads from adjoining cells. Structurally, therefore, a plant may be conceived to be built up of a nucleated cytoplasmic network, each nucleus with the branching cell plasm surrounding it being a center of activity. On this view a cell would retain to some extent its individuality, though, as Gardiner contends, the connecting threads would be the medium for the conduction of impulses and of food from a cell to those which lie around it. For the plant cell, therefore, as has long been accepted in the animal cell, the wall is reduced to a secondary position, and the active constituent is the nucleated cell plasm. It is not unlikely that the absence of a controlling nervous system in plants requires the plasm of adjoining cells to be brought into more immediate contact and continuity than is the case with the generality of animal cells, so as to provide a mechanism for harmonizing the nutritive and other functional processes in the different areas in the body of the plant. In this particular, it is of interest to note that the epithelial tissues in animals, where somewhat similar connecting arrangements occur, are only indirectly associated with the nervous and vascular systems, so that, as in plants, the cells may require, for nutritive and other purposes, to act and react directly on each other.

NERVE CELLS.

Of recent years great attention has been paid to the intimate structure of nerve cells, and to the appearance which they present when in the exercise of their functional activity. A nerve cell is not a secreting cell; that is, it does not derive from the blood or surrounding fluid a pabulum which it elaborates into a visible, palpable secretion characteristic of the organ of which the cell is a constituent element, to be in due course discharged into a duct which conveys the secretion out of the gland. Nerve cells, through the metabolic changes which take place in them in connection with their nutrition, are associated with the production of the form of energy specially exhibited by animals which possess a nervous system, termed nerve energy. It has long been known that every nerve cell has a body in which a relatively large nucleus is situated. A most important discovery was the recognition that the body of every nerve cell had one or more processes growing out from it. More recently it has been proved, chiefly through the researches of Schultze, His, Golgi, and Ramon y Cajal, that at least one of the processes, the axon of the nerve cell, is continued into the axial cylinder of a nerve fiber, and that in the multipolar nerve cell the other processes, or dendrites, branch and ramify for some distance away from the body. A nerve fiber is therefore an essential part of the cell with which it is continuous, and the cell, its processes, the nerve fiber and the collaterals which arise from the nerve fiber collectively form a neuron or structural nerve unit (Waldeyer). The nucleated

body of the nerve cell is the physiological center of the unit.

The cell plasm occupies both the body of the nerve cell and its processes. The intimate structure of the plasm has, by improved methods of observation introduced during the last eight years by Nissl, and conducted on similar lines by other investigators, become more definitely understood. It has been ascertained that it possesses two distinct characters which imply different structures. One of these stains deeply on the addition of certain dyes, and is named chromophile or chromatic substance; the other, which does not possess a similar property, is the achromatic network. The chromophile is found in the cell body and the dendritic processes, but not in the axon. It occurs in the form of granular particles, which may be scattered throughout the plasm, or aggregated into little heaps which are elongated or fusiform in shape and appear as distinct colored particles or masses. The achromatic network is found in the cell body and the dendrites, and is continued also into the axon, where it forms the axial cylinder of the nerve fiber. It consists apparently of delicate threads or fibrillæ, in the meshes of which a homogeneous material, such as is found in cell plasm generally, is contained. In the nerve cells, as in other cells, the plasm is without doubt concerned in the process of cell nutrition. The achromatic fibrillæ exercise an important influence on the axon or nerve fiber with which they are continuous, and probably they conduct the nerve impulses which manifest themselves in the form of nerve energy. The dendritic processes of a multipolar nerve cell ramify in close relation with similar processes branching from other cells in the same group. The collaterals and the free end of the axon fiber process branch and ramify in association with the body of a nerve cell or of its dendrites. We cannot say that these parts are directly continuous with each other to form an intercellular network, but they are apparently in apposition, and through contact exercise influence one on the other in the transmission of nerve impulses.

There is evidence to show that in the nerve cell the nucleus, as well as the cell plasm, is an effective agent in nutrition. When the cell is functionally active, both the cell body and the nucleus increase in size (Vas, G. Mann, Lugaro); on the other hand, when nerve cells are fatigued through excessive use, the nucleus decreases in size and shrivels; the cell plasm also shrinks, and its colored or chromophile constituent becomes diminished in quantity, as if it had been consumed during the prolonged use of the cell (Hodge, Mann, Lugaro). It is interesting also to note that in hibernating animals in the winter season, when their functional activity is reduced to a minimum, the chromophile in the plasm of the nerve cells is much smaller in amount than when the animal is leading an active life in the spring and summer (G. Levi).

When a nerve cell has attained its normal size it does not seem to be capable of reproducing new cells in its substance by a process of karyokinesis, such as takes place when young cells arise in the egg and in the tissues generally. It would appear that nerve cells are so highly specialized in their association with the evolution of nerve energy, that they have ceased to have the power of reproducing their kind, and the metabolic changes both in cell plasm and nucleus are needed to enable them to discharge their very peculiar function. Hence it follows that when a portion of the brain or other nerve-center is destroyed, the injury is not repaired by the production of fresh specimens of their characteristic cells, as would be the case in injuries to bones and tendons.

In our endeavors to differentiate the function of the nucleus from that of the cell

plasm, we should not regard the former as concerned only in the production of young cells, and the latter as the exclusive agent in growth, nutrition, and, where gland cells are concerned, in the formation of their characteristic products. As regards cell reproduction also, though the process of division begins in the nucleus in its chromosome constituents, the achromatic figure in the cell plasm undoubtedly plays a part, and the cell plasm itself ultimately undergoes cleavage.

A few years ago the tendency amongst biologists was to ignore or attach but little importance to the physiological use of the nucleus in the nucleated cell, and to regard the protoplasm as the essential and active constituent of living matter; so much so, indeed, was this the case that independent organisms regarded as distinct species were described as consisting of protoplasm destitute of a nucleus; also that scraps of protoplasm separated from larger nucleated masses could, when isolated, exhibit vital phenomena. There is reason to believe that a fragment of protoplasm, when isolated from the nucleus of a cell, though retaining its contractility and capable of nourishing itself for a short time, cannot increase in amount, act as a secreting structure, or reproduce its kind: it soon loses its activity, withers and dies. In order that these qualities of living matter should be retained, a nucleus is by most observers regarded as necessary (Nussbaum, Gruber, Haberlandt, Korschelt), and for the complete manifestations of vital activity both nucleus and cell plasm are required.

BACTERIA.

The observations of Cohn, made about thirty years ago, and those of De Bary shortly afterwards, brought into notice a group of organisms to which the name 'bacterium' or 'microbe' is given. They were seen to vary in shape: some were rounded specks called cocci, others were straight rods called bacilli, others were curved or spiral rods, vibrios or spirillæ. All were characterized by their extreme minuteness, and required for their examination the highest powers of the best microscopes. Many bacteria measure in their least diameter not more than $\frac{1}{25000}$th of an inch, $\frac{1}{10}$th the diameter of a human white blood corpuscle. Through the researches of Pasteur, Lord Lister, Koch, and other observers, bacteria have been shown to play an important part in nature. They exercise a very remarkable power over organic substances, especially those which are complex in chemical constitution, and can resolve them into simpler combinations. Owing to this property, some bacteria are of great economic value, and without their agency many of our industries could not be pursued; others again, and these are the most talked of, exercise a malign influence in the production of the most deadly diseases which afflict man and the domestic animals.

Great attention has been given to the structure of bacteria and to their mode of propagation. When examined in the living state and magnified about 2000 times, a bacterium appears as a homogeneous particle, with a sharp definite outline, though a membranous envelope or wall, distinct from the body of the bacterium, cannot at first be recognized; but when treated with reagents a membranous envelope appears, the presence of which, without doubt, gives precision of form to the bacterium. The substance within the membrane contains granules which can be dyed with coloring agents. Owing to their extreme minuteness it is difficult to pronounce an opinion on the nature of the chromatine granules and the substance in which they lie. Some observers regard them as nuclear material, invested by only a thin layer of protoplasm, on which view a bacterium would be a nucleated cell. Others consider the bac-

terium as formed of protoplasm containing granules capable of being colored, which are a part of the protoplasm, itself, and not a nuclear substance. On the latter view, bacteria would consist of cell plasm enclosed in a membrane and destitute of a nucleus. Whatever be the nature of the granule-containing material, each bacterium is regarded as a cell, the minutest and simplest living particle capable of an independent existence that has yet been discovered.

Bacteria cells, like cells generally, can produce their kind. They multiply by simple fission, probably with an ingrowth of the cell wall, but without the karyokinetic phenomena observed in nucleated cells. Each cell gives rise to two daughter cells, which may for a time remain attached to each other and form a cluster or a chain, or they may separate and become independent isolated cells. The multiplication, under favorable conditions of light, air, temperature, moisture and food, goes on with extraordinary rapidity, so that in a few hours many thousand new individuals may arise from a parent bacterium.

Connected with the life-history of a bacterium cell is the formation in its substance, in many species and under certain conditions, of a highly refractile shiny particle called a spore. At first sight a spore seems as if it were the nucleus of the bacterium cell, but it is not always present when multiplication by cleavage is taking place, and when present it does not appear to take part in the fission. On the other hand, a spore, from the character of its envelope, possesses great power of resistance, so that dried bacteria, when placed in conditions favorable to germination, can through their spores germinate and resume an active existence. Spore formation seems, therefore, to be a provision for continuing the life of the bacterium under conditions which, if spores had not formed, would have been the cause of its death.

The time has gone by to search for the origin of living organisms by a spontaneous aggregation of molecules in vegetable or other infusions, or from a layer of formless primordial slime diffused over the bed of the ocean. Living matter during our epoch has been, and continues to be, derived from pre-existing living matter, even when it possesses the simplicity of structure of a bacterium, and the morphological unit is the cell.

DEVELOPMENT OF THE EGG.

As the future of the entire organism lies in the fertilized egg cell, we may now briefly review the arrangements, consequent on the process of segmentation, which lead to the formation, let us say in the egg of a bird, of the embryo or young chick.

In the latter part of the last century, C. F. Wolff observed that the beginning of the embryo was associated with the formation of layers, and in 1817 Pander demonstrated that in the hen's egg at first one layer, called mucous, appeared, then a second or serous layer, to be followed by a third, intermediate or vascular layer. In 1828 von Baer amplified our knowledge in his famous treatise, which from its grasp of the subject created a new epoch in the science of embryology. It was not, however, until the discovery by Schwann of cells as constant factors in the structure of animals and in their relation to development that the true nature of these layers was determined. We now know that each layer consists of cells, and that all the tissues and organs of the body are derived from them. Numerous observers have devoted themselves for many years to the study of each layer, with the view of determining the part which it takes in the formation of the constituent parts of the body, more especially in the higher animals, and the important conclusion has been arrived at that each kind of tissue invariably arises from one of these layers and from no other.

The layer of cells which contributes, both as regards the number and variety of the tissues derived from it, most largely to the formation of the body is the middle layer or mesoblast. From it the skeleton, the muscles, and other locomotor organs, the true skin, the vascular system, including the blood, and other structures which I need not detail, take their rise. From the inner layer of cells or hypoblast, the principal derivatives are the epithelial lining of the alimentary canal and of the glands which open into it, and the epithelial lining of the air-passages. The outer or epiblast layer of cells gives origin to the epidermis or scarf skin and to the nervous system. It is interesting to note that from the same layer of the embryo arise parts so different in importance as the cuticle—a mere protecting structure, which is constantly being shed when the skin is subjected to the friction of a towel or the clothes—and the nervous system, including the brain, the most highly differentiated system in the animal body. How completely the cells from which they are derived had diverged from each other in the course of their differentiation in structure and properties is shown by the fact that the cells of the epidermis are continually engaged in reproducing new cells to replace those which are shed, whilst the cells of the nervous system have apparently lost the power of reproducing their kind.

In the early stage of the development of the egg, the cells in a given layer resemble each other in form, and, as far as can be judged from their appearance, are alike in structure and properties. As the development proceeds, the cells begin to show differences in character, and in the course of time the tissues which arise in each layer differentiate from each other and can be readily recognized by the observer. To use the language of von Baer, a generalized structure has become specialized, and each of the special tissues produced exhibits its own structure and properties. These changes are coincident with a rapid multiplication of the cells by cleavage, and thus increase in size of the embryo accompanies specialization of structure. As the process continues, the embryo gradually assumes the shape characteristic of the species to which its parents belonged, until at length it is fit to be born and to assume a separate existence.

The conversion of cells, at first uniform in character, into tissues of a diverse kind is due to forces inherent in the cells in each layer. The cell plasm plays an active though not an exclusive part in the specialization; for as the nucleus influences nutrition and secretion, it acts as a factor in the differentiation of the tissues. When tissues so diverse in character as muscular fiber, cartilage, fibrous tissues, and bone arise from the cells of the middle or mesoblast layer, it is obvious that, in addition to the morphological differentiation affecting form and structure, a chemical differentiation affecting composition also occurs, as the result of which a physiological differentiation takes place. The tissues and organs become fitted to transform the energy derived from the food into muscular energy, nerve energy, and other forms of vital activity. Corresponding differentiations also modify the cells of the outer and inner layers. Hence the study of the development of the generalized cell layers in the young embryo enables us to realize how all the complex constituent parts of the body in the higher animals and in man are evolved by the process of differentiation from a simple nucleated cell—the fertilized ovum. A knowledge of the cell and of its life-history is therefore the foundation-stone on which biological science in all its departments is based.

If we are to understand by an organ in the biological sense a complex body capable

of carrying on a natural process, a nucleated cell is an organ in its simplest form. In a unicellular animal or plant such an organ exists in its most primitive stage. The higher plants and animals again are built up of multitudes of these organs, each of which, whilst having its independent life, is associated with the others, so that the whole may act in unison for a common purpose. As in one of your great factories each spindle is engaged in twisting and winding its own thread, it is at the same time intimately associated with the hundreds of other spindles in its immediate proximity, in the manufacture of the yarn from which the web of cloth is ultimately to be woven.

It has taken more than fifty years of hard and continuous work to bring our knowledge of the structure and development of the tissues and organs of plants and animals up to the level of the present day. Amidst the host of names of investigators, both at home and abroad, who have contributed to its progress, it may seem invidious to particularize individuals. There are, however, a few that I cannot forbear to mention, whose claim to be named on such an occasion as this will be generally conceded.

Botanists will, I think, acknowledge Wilhelm Hofmeister as a master in morphology and embryology, Julius von Sachs as the most important investigator in vegetable physiology during the last quarter of a century, and Strasburger as a leader in the study of the phenomena of nuclear division.

The researches of the veteran professor of anatomy in Würzburg, Albert von Kölliker, have covered the entire field of animal histology. His first paper, published fifty-nine years ago, was followed by a succession of memoirs and books on human and comparative histology and embryology, and culminated in his great treatise on the structure of the brain, published in 1896. Notwithstanding the weight of more than eighty years, he continues to prosecute histological research, and has published the results of his latest, though let us hope not his last, work during the present year.

Amongst our own countrymen, and belonging to the generation which has almost passed away, was William Bowman. His investigations between 1840 and 1850 on the mucous membranes, muscular fiber, and the structure of the kidney together with his researches on the organs of sense, were characterized by a power of observation and of interpreting difficult and complicated appearances which has made his memoirs on these subjects landmarks in the history of histological inquiry.

Of the younger generation of biologists Francis Maitland Balfour, whose early death is deeply deplored as a loss to British science, was one of the most distinguished. His powers of observation and philosophic perception gave him a high place as an original inquirer, and the charm of his personality—for charm is not the exclusive possession of the fairer sex—endeared him to his friends.

GENERAL MORPHOLOGY.

Along with the study of the origin and structure of the tissues of organized bodies, much attention has been given during the century to the parts or organs in plants and animals, with the view of determining where and how they take their rise, the order of their formation, the changes which they pass through in the early stages of development, and their relative positions in the organism to which they belong. Investigations on these lines are spoken of as morphological, and are to be distinguished from the study of their physiological or functional relations, though both are necessary for the full comprehension of the living organism.

The first to recognize that morphological

relations might exist between the organs of a plant, dissimilar as regards their function, was the poet Goethe, whose observations, guided by his imaginative faculty, led him to declare that the calyx, corolla, and other parts of a flower, the scales of a bulb, etc., were metamorphosed leaves, a principle generally accepted by botanists, and indeed extended to other parts of a plant, which are referred to certain common morphological forms although they exercise different functions. Goethe also applied the same principle in the study of the skeletons of vertebrate animals, and he formed the opinion that the spinal column and the skull were essentially alike in construction, and consisted of vertebræ, an idea which was also independently conceived and advocated by Oken.

The anatomist who in our country most strenuously applied himself to the morphological study of the skeleton was Richard Owen, whose knowledge of animal structure based upon his own dissections, was unrivalled in range and variety. He elaborated the conception of an ideal, archetype vertebrate form which had no existence in nature, and to which, subject to modifications in various directions, he considered all vertebrate skeletons might be referred. Owen's observations were conducted to a large extent on the skeletons of adult animals, of the knowledge of which he was a master. As in the course of development modifications in shape and in the relative position of parts not unfrequently occur and their original character and place of origin become obscured, it is difficult, from the study only of adults, to arrive at a correct interpretation of their morphological significance. When the changes which take place in the skull during its development, as worked out by Reichert and Rathke, became known and their value had become appreciated, many of the conclusions arrived at by Owen were challenged and ceased to be accepted. It is, however, due to that eminent anatomist to state from my personal knowledge of the condition of anatomical science in this country fifty years ago, that an enormous impulse was given to the study of comparative morphology by his writings, and by the criticisms to which they were subjected.

There can be no doubt that generalized arrangements do exist in the early embryo which, up to a certain stage, are common to animals that in their adult condition present diverse characters, and out of which the forms special to different groups are evolved. As an illustration of this principle, I may refer to the stages of development of the great arteries in the bodies of vertebrate animals. Originally, as the observations of Rathke have taught us, the main arteries are represented by pairs of symmetrically arranged vascular arches, some of which enlarge and constitute the permanent arteries in the adult, whilst others disappear. The increase in size of some of these arches, and the atrophy of others, are so constant for different groups that they constitute anatomical features as distinctive as the modifications in the skeleton itself. Thus in mammals the fourth vascular arch on the left side persists, and forms the arch of the aorta; in birds the corresponding part of the aorta is an enlargement of the fourth right arch, and in reptiles both arches persist to form the great artery. That this original symmetry exists also in man we know from the fact that now and again his body, instead of corresponding with the mammalian type, has an aortic arch like that which is natural to the bird, and in rarer cases even to the reptile. A type form common to the vertebrata does therefore in such cases exist, capable of evolution in more than one direction.

The reputation of Thomas Henry Huxley as a philosophic comparative anatomist rests largely on his early perception of,

and insistence on, the necessity of testing morphological conclusions by a reference to the development of parts and organs, and by applying this principle in his own investigations. The principle is now so generally accepted by both botanists and anatomists that morphological definitions are regarded as depending essentially on the successive phases of the development of the parts under consideration.

The morphological characters exhibited by a plant or animal tend to be hereditarily transmitted from parents to offspring, and the species is perpetuated. In each species the evolution of an individual, through the developmental changes in the egg, follows the same lines in all the individuals of the same species, which possess therefore in common the features called specific characters. The transmission of these characters is due, according to the theory of Weismann, to certain properties possessed by the chromosome constituents of the segmentation nucleus in the fertilized ovum, named by him the germ plasm, which is continued from one generation to another, and impresses its specific character on the egg and on the plant or animal developed from it.

As has already been stated, the special tissues which build up the bodies of the more complex organisms are evolved out of cells which are at first simple in form and appearance. During the evolution of the individual, cells become modified or differentiated in structure and function, and so long as the differentiation follows certain prescribed lines the morphological characters of the species are preserved. We can readily conceive that, as the process of specialization is going on, modifications or variations in groups of cells and the tissues derived from them, notwithstanding the influence of heredity, may in an individual diverge so far from that which is characteristic of the species as to assume the arrangements found in another species, or even in another order. Anatomists had indeed long recognized that variations from the customary arrangement of parts occasionally appeared, and they described such deviations from the current descriptions as irregularities.

DARWINIAN THEORY.

The signification of the variations which arise in plants and animals had not been apprehended until a flood of light was thrown on the entire subject by the genius of Charles Darwin, who formulated the wide-reaching theory that variations could be transmitted by heredity to younger generations. In this manner he conceived new characters would arise, accumulate, and be perpetuated, which would in the course of time assume specific importance. New species might thus be evolved out of organisms originally distinct from them, and their specific characters would in turn be transmitted to their descendants. By a continuance of this process new species would multiply in many directions, until at length from one or more originally simple forms the earth would become peopled by the infinite varieties of plant and animal organisms which have in past ages inhabited, or do at present inhabit, our globe. The Darwinian theory may therefore be defined as Heredity modified and influenced by Variability. It assumes that there is an hereditary quality in the egg which, if we take the common fowl for an example, shall continue to produce similar fowls. Under conditions, of which we are ignorant, which occasion molecular changes in the cells and tissues of the developing egg, variations might arise, in the first instance probably slight, but becoming intensified in successive generations, until at length the descendants would have lost the characters of the fowl and have become another species. No precise estimate has been ar-

rived at, and indeed one does not see how it is possible to obtain it, of the length of years which might be required to convert a variation, capable of being transmitted, into a new and definite specific character.

The circumstances which, according to the Darwinian theory, determined the perpetuation by hereditary transmission of a variety and its assumption of a specific character depended, it was argued, on whether it possessed such properties as enabled the plant or animal in which it appeared to adapt itself more readily to its environment, *i. e.*, to the surrounding conditions. If it were to be of use the organism in so far became better adapted to hold its own in the struggle for existence with its fellows and with the forces of nature operating on it. Through the accumulation of useful characters the specific variety was perpetuated by natural selection so long as the conditions were favorable for its existence, and it survived as being the best fitted to live. In the study of the transmission of variations which may arise in the course of development it should not be too exclusively thought that only those variations are likely to be preserved which can be of service during the life of the individual, or in the perpetuation of the species, and possibly available for the evolution of new species. It should also be kept in mind that morphological characters can be transmitted by hereditary descent, which, though doubtless of service in some bygone ancestor, are in the new conditions of life of the species of no physiological value. Our knowledge of the structural and functional modifications to be found in the human body, in connection with abnormalities and with tendencies or predisposition to diseases of various kinds, teaches us that characters which are of no use, and indeed detrimental to the individual, may be hereditarily transmitted from parents to offspring through a succession of generations.

Since the conception of the possibility of the evolution of new species from pre-existing forms took possession of the minds of naturalists, attempts have been made to trace out the lines on which it has proceeded. The first to give a systematic account of what he conceived to be the order of succession in the evolution of animals was Ernst Haeckel, of Jena, in a well-known treatise. Memoirs on special departments of the subject, too numerous to particularize, have subsequently appeared. The problem has been attacked along two different lines: the one by embryologists, of whom may be named Kowalewsky, Gegenbaur, Dohrn, Ray Lankester, Balfour and Gaskell, who with many others have conducted careful and methodical inquiries into the stages of development of numerous forms belonging to the two great divisions of the animal kingdom. Invertebrates, as well as vertebrates, have been carefully compared with each other in the bearing of their development and structure on their affinities and descent, and the possible sequence in the evolution of the Vertebrata from the Invertebrata has been discussed. The other method pursued by paleontologists, of whom Huxley, Marsh, Cope, Osborn and Traquair are prominent authorities, has been the study of the extinct forms preserved in the rocks and the comparison of their structure with each other and with that of existing organisms. In the attempts to trace the line of descent the imagination has not unfrequently been called into play in constructing various conflicting hypotheses. Though from the nature of things the order of descent is, and without doubt will continue to be, ever a matter of speculation and not of demonstration, the study of the subject has been a valuable intellectual exercise and a powerful stimulant to research.

We know not as regards time when the fiat went forth, 'Let there be Life, and there was Life.' All that we can say is that it must have been in the far-distant past, at a period so remote from the present that the mind fails to grasp the duration of the interval. Prior to its genesis our earth consisted of barren rock and desolate ocean.

When matter became endowed with life, with the capacity of self-maintenance and of resisting external disintegrating forces, the face of nature began to undergo a momentous change. Living organisms multiplied, the land became covered with vegetation, and multitudinous varieties of plants, from the humble fungus and moss to the stately palm and oak, beautified its surface and fitted it to sustain higher kinds of living beings. Animal forms appeared, in the first instance simple in structure, to be followed by others more complex, until the mammalian type was produced. The ocean also became peopled with plant and animal organisms, from the microscopic diatom to the huge leviathan. Plants and animals acted and reacted on each other, on the atmosphere which surrounded them and on the earth on which they dwelt, the surface of which became modified in character and aspect. At last Man came into existence. His nerve-energy, in addition to regulating the processes in his economy which he possesses in common with animals, was endowed with higher powers. When translated into psychical activity it has enabled him throughout the ages to progress from the condition of a rude savage to an advanced stage of civilization; to produce works in literature, art and the moral sciences which have exerted, and must continue to exert, a lasting influence on the development of his higher Being; to make discoveries in physical science; to acquire a knowledge of the structure of the earth, of the ocean in its changing aspects, of the atmosphere and the stellar universe, of the chemical composition and physical properties of matter in its various forms, and to analyze, comprehend and subdue the forces of nature.

By the application of these discoveries to his own purposes Man has, to a large extent, overcome time and space; he has studded the ocean with steamships, girdled the earth with the electric wire, tunneled the lofty Alps, spanned the Forth with a bridge of steel, invented machines and founded industries of all kinds for the promotion of his material welfare, elaborated systems of government fitted for the management of great communities, formulated economic principles, obtained an insight into the laws of health, the causes of infective diseases, and the means of controlling and preventing them.

When we reflect that many of the most important discoveries in abstract science and in its applications have been made during the present century, and indeed since the British Association held its first meeting in the ancient capital of your county sixty-nine years ago, we may look forward with confidence to the future. Every advance in science provides a fresh platform from which a new start can be made. The human intellect is still in process of evolution. The power of application and of concentration of thought for the elucidation of scientific problems is by no means exhausted. In science is no hereditary aristocracy. The army of workers is recruited from all classes. The natural ambition of even the private in the ranks to maintain and increase the reputation of the branch of knowledge which he cultivates affords an ample guarantee that the march of science is ever onwards, and justifies us in proclaiming for the next century, as in the one fast ebbing to a close, that Great is Science, and it will prevail.

William Turner.

ORIGINAL INVESTIGATIONS BY ENGINEERING SCHOOLS A DUTY TO THE PUBLIC AND TO THE PROFESSION.

THE function of the modern university includes much more than the mere imparting of instruction to its students. In a newly recognized, important sense, the entire public must be considered university students, and by frequent publications, addressed to different classes of people, by extension lectures and possibly by correspondence instruction, the modern university must seek to educate this greater student body. Besides this no university, no department even, of a university can be considered to be doing living, vital work, unless in addition to its routine of instruction it is carrying on original investigations. Otherwise its work will be merely mechanical. No student can be properly educated without *bringing him* into such close contact with veiled truth that he feels the very throb of her pulse, and receives direct from her the inspiration to become himself a searcher after truth.

It is the object of this paper to make a plea that the function of the modern technical school should be, in its particular field, closely similar to that of the university, as outlined above. The author believes that in addition to educating engineers, the technical school should, by special courses supplying special equipment, train leaders for all the industrial and commercial work of modern civilization. More than this, he believes that by the publication and distribution of frequent bulletins on technical, industrial and commercial subjects, by its faculty taking part in the meetings and conventions of the various technical, industrial and commercial interests and societies, and eventually perhaps by systematic extension lectures and correspondence courses, the technical school should seek to educate the industrial and commercial public in the applications of science to their work.

It is the special object of this paper, however, to make a plea for systematic, original investigation in technical schools. The necessity for work along this line has been so great and so plainly apparent that a great deal has already been accomplished. The term *original investigation* should be understood to include much besides experimental research. The writing of good technical books, for example, involves a large amount of original study and research, for such books should never be mere compilations. In the columns of one of our principal technical journals 73 technical books were reviewed during the year 1899, and 25 of these were written by professors in engineering schools. There is not a single technical journal, and perhaps not an important technical society publication in the country to whose columns frequent contributions are not made by engineering educators. The current of progress of technical education is sweeping engineering professors farther and farther away from the old exclusive devotion to class room instruction, and more and more bearing them into active participation in the daily outside work of their professions.

The development of original investigation at technical schools has been especially rapid in late years along the line of experimental research. The modern methods of instruction require extensive and expensive laboratory equipment, which is also available for experimental research. The multitude of subjects pressingly needing such research is so great that energetic engineering instructors are naturally led into experimental investigations. Frequent reports of the results of such work are seen in the technical society proceedings. Also most engineering schools maintain regular publications, in which the results of many experimental investigations by both faculty and undergraduates are reported. It is impossible to mention here many of the

numerous important experimental investigations which have been made at American engineering schools, but attention will be called to two cases: first, all are familiar with the important work in connection with paving brick which has been done at the universities of Ohio and Illinois, and which has been accepted as authoritative by both engineers and manufacturers; second, the great hydraulic laboratory at Cornell has required the most lavish expenditure of money devoted exclusively to preparation for experimental research in a single line of work yet seen at an American technical school.

The great value of such investigations to the engineering profession is readily apparent. The value in connection with the instruction of engineering students is also great. Bringing the student into personal contact with the progress of such investigations, carried on by his instructors, does much to awaken in him professional enthusiasm and an ambition to become himself a contributor in the future to the common stock of technical knowledge. The student is led to see that there is much more in engineering education than the mere absorption of knowledge, and much more to engineering practice than the mere routine of carrying out pre-established methods. He sees that he must learn to think for himself in his future work, and to investigate for himself the problems which he will encounter. In the simpler work connected with experimental investigations bright, reliable students can often be employed to advantage. This is especially true in work suited to thesis investigations. The author knows of no more valuable training a student can have than to carry out successfully an experimental research, overcoming all the unforseen difficulties sure to be encountered, and at the end completely digesting the results obtained. The author believes, however, that all experimental work by undergraduates should be done under very close supervision by a skilled instructor. Much valuable thesis work has been done in this way at engineering schools.

While much has already been accomplished in orginal investigations at American technical schools, such work has heretofore, with few important exceptions, been carried on spasmodically, with no systematic pre-arranged plan. The author believes that this should now be changed, and that wherever possible technical schools should deliberately plan for investigations as a part of their regular work. Each school should decide what lines of work are best suited to its location and circumstances. Proper space and equipment should be provided. The faculty should be made large enough to permit the necessary time to be devoted to the work. Funds should be provided to meet the expenses. Arrangements should be made for the regular publication of the results.

Investigations which can be carried out at engineering schools are of two kinds: first, those mainly of professional interest and value; and second, investigations whose results have a considerable commercial, industrial and public, as well as professional value.

As to investigations of the first kind it may be said that the practicing engineer frequently encounters problems which ought to be investigated experimentally, but it is seldom the case that he can command the necessary laboratory equipment or the time for such work, or induce his employers to furnish the necessary funds. Such problems should be referred to the schools and there investigated. Thus the schools may perform their duty to the profession, and may ask in return, as they do even now, that the practicing expert shall give them the benefit of his experience, in non-resident lecture courses. There will result that co-operation and close association between the engineering educator and the practicing

engineer which is so essential to the best interests of the profession.

As regards investigations having a commercial and industrial value, attention may be called to the prominence which has recently been given to discussion of the value of scientific technical training for the leaders and workers in our manufacturing and commercial industries. The mono-technic and the trade schools of Germany have been held up as models for the world. The author believes that, under American conditions, the first decisive step towards solving this problem should be taken at the technical schools, especially the state colleges and state universities which are the beneficiaries of the Morrill government aid laws. The nearest approach now made to systematic technical education for one industry in this country is seen at our agricultural schools and experiment stations. At the best of these schools not only are the students given a thorough scientific education and training for leaders in agricultural work, but also extensive scientific agricultural experiments and investigations are continually being carried on. The results are systematically published and distributed in bulletins. The faculties attend the regular meetings of the institutes and conventions of agricultural interests, and there inform the public concerning the results of the college work and the principles of scientific agriculture. The author believes that similar training and aid should be given by our technical schools to American manufacturing, commercial and other industrial interests. At least, investigations helpful to these interests should be undertaken, and the results systematically published. The school which will undertake such work will receive hearty support from the industrial interests of the country, and means for carrying on the work will not be lacking.

In a new and rapidly developing country like ours there are many yet untouched resources. It would greatly accelerate the development of these if scientific investigations of their possibilities were made by the technical schools. For example, in the case of quarries, deposits of cement materials and clay deposits, both the raw materials and the finished products can be carefully tested and their qualities published. Again, in processes of manufacture, the effect of different processes in the quality of the product can be studied. New applications of botany, chemistry and physics to manufacturing processes can be found.

In fact the subjects suitable for investigation at engineering schools are very numerous, and no attempt will be made here to give an exhaustive list. The following may be mentioned:

Theoretical Mechanics.—Experimental studies, accompanied by mathematical investigations of the theory, may be made of such problems as the actual pressure against retaining walls, the theory of concrete and steel combinations, problems in hydraulics, and many others.

Materials of Construction.—The methods for testing the materials of construction need extensive experimental investigation, and should be completely standardized. The properties of both long used and of new materials may be studied and made known. Standard specifications may be prepared for the properties developed by the standard tests.

Sewage Disposal and Water Supply.—The methods of analysis of sewage and water need careful experimental study to determine the best methods and the interpretation to be placed on the results. Analyses of sewage and water can be made for the municipalities and corporations of the state. Many sewage and water purification problems can be studied experimentally, and systematic examinations and reports can be made of existing plants in the State

Steam and Electrical Engineering.—Laboratories can be provided for tests of different kinds of machinery, and for the experimental investigation of problems of correct design. Efficiency tests of outside plants can be made.

Mining Engineering.—Geological studies of deposits of building stones, cement materials, clays, fuels and ores can be made, and the qualities tested.

Manufacturing.—Applications of science to manufacturing and the comparative values of different processes can be studied, as already mentioned. With the aid of statistics, political economy as related to manufacturing, can be studied.

Transportation.—Good roads and road materials in the State can be studied. Laboratories can be established, fitted for tests of transportation machinery. The political economy of transportation problems can be studied.

The author does not claim that any one school should undertake all of the above lines of work. On the contrary, the work undertaken by any one school should be restricted to what it can carry on for a long period of time, and so extensively and thoroughly that the results shall be conclusive. Particular schools would naturally become authorities in particular lines, and their work would not be duplicated by others, although many lines of work would need to be carried on by several schools, because local conditions differ.

As an illustration of a modest and imperfect beginning of such work, made under many difficulties, the author would say that at the school with which he is connected the following lines of work are now under way:

The college has a sewage disposal plant which purifies about 50,000 gallons per day. Regular analyses in connection with this plant are made, complete records are kept, and investigations with the plant are under way. Special tests with smaller apparatus are planned. The college has just co-operated with a neighboring city, securing and publishing at the expense of the city the preliminary data for the design of a purification plant for 2,000,000 gallons of sewage per day. The college proposes to examine and report upon sewage disposal plants as fast as they are installed in the State. In connection with the clay interests of the State quite a large number of plants have been visited, samples of clay and brick secured for tests, the clays and processes of manufacture studied, and several thousand tests are under way. Samples of new clay deposits are frequently received, analyzed and reported upon. An appropriation has been made for starting a ceramic laboratory, modelled after the one at the Ohio State University. A set of tests of the heating properties of the coals of the State is under way. Tests of the building and paving materials of the State are being made, and extensive statistics of brick paving collected. Special investigations of timely interest are taken up as opportunity permits. It is proposed to extend this work.

It is obvious that if the extension of the work of the modern technical school advocated in this paper could be made to the utmost possible extent, the status of the technical school would be greatly changed from what it now is. No longer could the schools be considered as existing simply for the benefit of its students. All practicing engineers would equally consider it theirs, and the great industrial and commercial interests of the country would consider it theirs. Such a technical school would be one of the most potent agencies imaginable for the betterment of the welfare of the people, and for the progress of modern civilization.

A. Marston.

Iowa State College.

*THE DEVELOPMENT OF THE CONGER EEL.**

ON July 31st, Dr. Porter E. Sargent, while on the U. S. Fish Commission vessel *Grampus* on the tile-fish banks (about 40 miles south of South Shoal), secured a number of species of pelagic fish eggs. One of these is very probably that of the Conger eel.

I have followed the development of this egg, and the larvæ hatched from it during two weeks. In view of the fact that no ripe eel eggs had been seen except in a limited region of the Mediterranean, a brief résumé of the results of my work on these eggs may be of interest. But first a note on the modern phase of the eel question will not be out of place.

In 1888, Raffaele figured and described a number of species of pelagic eggs which, on account of the shape of the larvæ they produced, he referred to various species of eels without a further attempt to refer them to definite species.

In 1897, Grassi published his series of epoch-making works on the eel question. He also found the eggs described by Raffaele, but of more importance was his identification of various species of Leptocephali as the normal larval stages of various eels. His conclusions in brief were: 1st, that the eggs of eels mature at great depths, 500 meters; 2d, that the eggs, except occasionally, develop at great depths; 3d, that the eggs give rise to a præ-larva, that this gives rise to a larva (the Leptocephalus), that this in turn gives rise to a hemilarva which finally is metamorphosed into the definitive adult which may be much shorter than the Leptocephalus from which it arose; 4th, that the egg of the common eel is without an oil globule.

The eggs secured during this summer are very nearly, if not quite like one of those described by Raffaele. They have all the characters of a pelagic egg, and Grassi was probably mistaken when he stated that these eggs come to the surface only occasionally. They are large, measuring from 2.4 to 2.75 mm. from membrane to membrane. The yolk is in segments, and measures 1.75 to 2 mm. in diameter, thus leaving a large perivitelline space. There are usually several oil globules, one of which is very much larger than the others. Some of these eggs hatched on the fourth day, others not until several days later. There are several distinct and unique features in the development, most of which have been well described and figured by Raffaele. (I have not seen Grassi's illustrated work.)

First among the peculiar features is the shape of the yolk. This in later stages of development becomes a long, slender mass reaching from the heart along the base of the alimentary canal to near the anus. This mass becomes constricted in places and the last seen of the yolk is a series of small disconnected bead-like masses distributed at intervals along the base of the alimentary canal. The yolk mass in the yolk sack diminishes very rapidly, partly by absorption, and partly, no doubt, by becoming located in the sub-alimentary yolk mass. A constriction is formed between it and the posterior yolk to which it forms a sort of handle. The oil spheres remain in the handle of the yolk mass. This elongation of the yolk is a definite adaptation to the elongate body and eeling progression of the larva.

The number of abdominal protovertebræ is exceptionally large, numbering between 65 and 71 in the present case.

The medulla becomes early and remains late a large, conspicuous, thin-roofed vesicle.

The color appears late. Only black pigments appear. In the last stages reached it

* By permission of Dr. H. C. Bumpus, director of the Woods Holl Laboratory of the U. S. Fish Commission. The details will be published by the Fish Commission.

consists of a series of ten spots along the region of the alimentary canal and lower part of the tail, a black spot about the end of the tail and another at the tip of the lower jaw, with a few cells on the upper jaw.

Especially noteworthy is the development of enormous fang-like teeth, four pairs in each jaw. The upper decrease in length from the front backwards, while those of the lower jaw are nearly of uniform size.

When first hatched the larvæ floated vertically, near the surface, heads up, tails down. Later they assumed the horizontal position and explored all parts of the vessel in which they were contained, progressing in approved eel fashion and biting at nearly everything touched.

The evidence that the eggs are those of the Conger is not positive. If Grassi is right, these eggs cannot belong to the common eel. The Conger eel is the only other one abundant in the region in which the eggs were collected and was caught in numbers at the time the eggs were collected. The serious objection to referring them to the Conger is the large number of segments in front of the anus. Since, however, according to Grassi, the anus migrates to near the end of the tail during the changes to the Leptocephalus stage, the number of segments in front of the anus is probably not positively available in the identification of the larva.

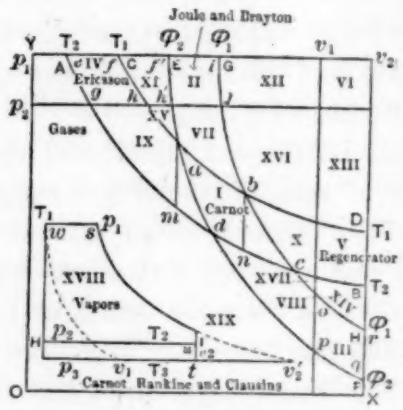
Carl H. Eigenmann.

Woods Holl, Mass., August 25, 1900.

HEAT-ENGINE DIAGRAMS.

The accompanying diagram, in which are shown the possible compositions of the four standard thermodynamic lines in the formation of heat-engine diagrams or thermodynamic cycles, has been found so useful during twenty years' experience in its employment that it has seemed possible that it may prove deserving of extended publication. It has just been engraved in this particular form for illustration of a new edition of the 'Manual of the Steam-engine.' Gas-engine cycles are seen to number no less than seventeen, of which a large proportion are mechanically and kinematically practical, and a half-dozen of which have been adopted or designed by engineers.

The Carnot, or Sterling—*I, a b c d*—and its equivalent, *a b n m*, or *V*, the regenerator cycle, only, it is recognized, can yield maximum efficiency, as a thermodynamic



proposition; but the Joule, or Brayton, and the Ericsson, among the gas-engine cycles and the Rankins and Clausius among vapor-engine cycles have been found available by designers and builders, and it is probable that, among the infinite number of conceivable cycles outside the class here illustrated, many may be found capable of meeting the demand of the engineer for a practical union of thermodynamic, mechanical and kinematic closed cycles.

The production of the cycle of Carnot is not a difficult task as a matter of design but, in the case of the gas-engine, it involves too extensive a variation of volume to find place in application. It is far more practicable with vapor-engines and Cotterill long since suggested a practical approximation of which the engineers of our own day are beginning to avail themselves.

R. H. Thurston.

HERMAN ANDREAS LOOS.

THE death of Dr. Herman Andreas Loos which has already been noticed in these columns, adds another to the long list of men of science whose lives have been blotted out by the scourges of the tropics.

Dr. Loos, though a very young man, was a chemist of exceptional promise. He was granted the degree of Bachelor of Science by the College of the City of New York in 1895. In 1897 he entered the School of Chemistry of Columbia University. When temporary business reverses removed the available funds for the completion of his education, he put his shoulder to the wheel and for two years before he entered Columbia taught in both the day and the night schools of this city. While doing his graduate work in the University he ably filled the instructorship in Chemistry in the East Side Evening High School. As an honor for his ability and perseverance he was awarded the University Fellowship in Chemistry for 1899–1900.

His principal contributions to the literature of chemistry are: 'The Electrolytic Determination of Zinc in Amalgam' (thesis for M. A.); 'A Study on the Metallic Carbonyls and their Decomposition (*School of Mines Quarterly 21*, 182); 'The Decomposition of Nickel Carbonyl in Solution' (*Journal American Chemical Society 22*, 144); 'A Study on Colophony Resin' (thesis for Ph.D.). In the study on Colophony Resin he has decided two controverted points, viz: that abietic acid will form an anhydride on heating, and that it is not an oxidation product of turpentine. He has also developed a new method for the preparation of pure abietic acid and established its formula by a number of analyses. Many new salts were prepared and their decomposition both by water and sunlight, noted. The whole work is of great theoretical and practical interest.

Immediately after receiving his degree Dr. Loos was appointed assistant in analytical chemistry in Columbia University. He resigned this position, however, to accept a flattering offer from the Copper Corporation of Chili, and it was while en route to Chañaral that he was stricken with yellow fever, of which he died July 17th.

At the age of twenty-four, by his own efforts, he had earned an education and established for his name an honorable place in the literature of his profession. No finer tribute can be paid to his energy and ability and ambition. Strange indeed must be one's thoughts when it is realized that the victims of yellow fever on board the steamship *Chili* were Italians or Chinese laborers with the one exception, the brilliant, energetic, educated Dr. Loos.

MILTON C. WHITAKER.

COLUMBIA UNIVERSITY,
September 1, 1900.

SCIENTIFIC BOOKS.

Photometrical Measurements and Manual for the general Practice of Photometry with especial Reference to the Photometry of Arc and Incandescent Lamps. By WILBUR M. STINE, Ph.D. New York, The Macmillan Company.

The scope of this little manual is indicated in its subtitle. The arrangement and proportioning of the material look always toward electric light photometry. Subjects which have a scientific, rather than an industrial interest, like spectrophotometry, are briefly dealt with, or omitted altogether, and the gas-engineer will find no reference to the special problems with which he has to struggle. Within the limits set by himself, Dr. Stine has produced a useful book. Less compact than Krüss, less comprehensive than Palaz, it is perhaps more directly adapted to the student than either. The material is judiciously selected, the discussions are clear and careful, the bibliographical references amply sufficient for the purposes of the book.

Some two-thirds of the volume are occupied in discussion and criticism of photometric instruments and standards of light, thirty or forty pages are given to general and theoretical

considerations, and the remainder is devoted to practical suggestions and directions.

In the discussions of photometric apparatus, such types have been selected as have been shown by experience to be really useful. Among these, the Bunsen screen holds easily the first place, from actual use, convenience, and sensitiveness, though attention might well have been called to its two notable weaknesses:

1. That it violates a fundamental principle of photometric construction, namely, that the portions of the photometric screen which are used for comparison should be illuminated each by one only of the lights to be compared, and not by both. The violation of this principle renders it possible, as is shown in the analytic discussion, to make settings in any one of three ways, which may give quite different readings, so that agreement is only obtained (and not surely even so) by reversing the instrument. How many users of the Bunsen screen for industrial purposes habitually reverse their photometers?

2. That the ordinary binocular use of this instrument is attended by the possibility of a considerable constant error. This is indeed pointed out on page 210, but is of sufficient importance to deserve mention in the description of the photometer itself.

It is questionable also whether the old shadow photometer is not too hardly dealt with. The illustration on page 54, though similar to that generally given in books on the subject, affords no idea of the proper use of the instrument. When arranged in the most advantageous manner this photometer becomes convenient in use to an extent hardly approached by any other form, and sufficiently sensitive for most work.

The bolometer, as a photometer, is dismissed with a few lines, yet it is worth noting that while energy measurers—like the bolometer—which can be made to register their results mechanically, do not measure the physiological sensation of light, yet for certain purposes they may be most useful. The variation in brightness of a light, within not too large limits, takes place generally without changing materially the character of the light, and hence is proportional to the corresponding change in energy. Such questions as the steadiness of a standard can be investigated by means of a bolometer with far more precision than by any photometric arrangement. No photometric indictment against the standard candle has ever approached in severity the curves obtained by Nichols and Sharp, in the work referred to by the author.

The method is recommended in the chapter on arc light photometry, of calibrating an incandescent lamp at white heat, by comparing in succession lights of higher and higher incandescence, starting with the ordinary yellowish standard, until through a series of steps the required limit is reached. This is a questionable method in practice. As the change of color in the successive steps is always in the same direction, from yellow toward white, errors made on account of the differing colors of the lights are likely to be always in the same direction, and therefore cumulative. I have found it very difficult to make a series of measurements of this kind tally in their final results with a direct comparison between the limits of the series made with a flicker photometer.

But these are small questions and affect but little the value of a book which may be recommended to students of the subject as a safe and efficient guide.

Frank P. Whitman.

LIVERPOOL MARINE BIOLOGICAL COMMITTEE'S MEMOIRS.

Numbers II. and III. of the Liverpool Marine Biological Committee's memoirs have recently come to hand. It was hardly to be expected that the standard of scientific excellence set by No. I. of the series, on *Ascidia* (see Science, January 19, 1900), written by the most experienced ascidiologist living, could be reached by all succeeding numbers. If, however, the two now under review may be accepted as establishing the quality of those that are to be prepared by specialists less distinguished than is Professor Herdman, the writer of the first number and editor of the series, a set of very valuable little books is to be the outcome of this unique undertaking.

Their usefulness will be by no means restricted to English laboratories of elementary

instruction, but will extend to the reference libraries of many professional zoologists.

Number II., by Mr. J. Johnstone, is on *Cardium;* and number III., by H. C. Chadwick, is on *Echinus.* The former contains 84 pp. and 7 pls.; the latter 28 pp. and 5 pls.

In *Cardium* the sections, 'General Organization, Mantle and Foot,' 'Shell,' 'Alimentary Canal,' 'Branchia,' 'Vascular System,' and 'Course of the Circulation,' are particularly well done. One rarely finds in works on the lamellibranchs of the general scope and purpose of this the crystalline style and the method of extending the siphons and foot better treated than here. The renal, nervous and reproductive systems do not fare quite so well, relatively. The histology of the nervous system, for example, is not touched upon at all, while it is entered into with some detail for all the other systems.

The treatment of the renal system is somewhat deficient in illustration, and consequently lacks to some extent in clearness. And here one wonders why the terms 'organ of Bojanus' and nephridia, so well established in lamellibranch morphology, are not even mentioned.

The absence of any reference to the cœlon, at least under that name, is strange.

A feature of this particular monograph, and one which will undoubtedly both extend and enhance its local value, is an appendix on 'The Economy of the Cockle, with special reference to the Lancashire Sea-Fisheries District.'

The *Echinus*, though perhaps not reaching at any point quite so high a level of descriptive excellence as does *Cardium* in a few sections, is more even. It is good throughout.

Both monographs contain much evidence that their authors have not only a large fund of first-hand knowledge of their subjects, but have also wide acquaintance with the original literature bearing upon them.

One constantly wishes that zoological treatises of this general type might contain more physiology and natural history with the morphology than they do; but here the desiderata are usually beyond the power of the authors to remedy. The three numbers of this series thus far put out are certainly less defective in this way than are many general works.

None of the numbers thus far issued have either tables of contents or indexes, and they should certainly have both; their value would be greatly enhanced thereby.

I would again express regret that the volumes cannot be more securely bound. A number of forms in the copy of *Cardium* that has come into my hands are now nearly ready to fall out, and the book has had no hard usage. The educational worth of the books certainly ought to insure them a place in many laboratories and reference libraries; and their usefulness ought not to be impaired by defective construction.

WM. E. RITTER.

SCIENTIFIC JOURNALS AND ARTICLES.

Popular Astronomy for August and September, published at Northfield, Minn., contains, as leading articles, views of some prominent astronomers, about the present opposition of the planet Eros as favorable for a study of this new planet's parallax. If its parallax can be obtained, micrometrically and photographically as accurately as is now believed, the result will help to a better knowledge of the solar parallax. Such knowledge would improve most of the constants of the solar system. S. J. Brown, Astronomical Director of the United States Naval Observatory, has prepared the first and second articles. The first is on the feasibility of obtaining the solar parallax from simultaneous micrometric observations of Eros, and the second is a translation from the French of two circulars issued by the International Astrophotographic Conference at its meetings in July and August last, giving instructions to all the astronomers of the world who are expected to co-operate in observing Eros during September and October. Director Brown gives useful comments on these circulars. Other articles are: 'Ptolemy's Theorem on the apparent Enlargement of the Sun and Moon near the Horizon,' by Dr. T. J. J. See, Washington, D. C.; 'Total Eclipse of May 28, 1900,' by Professor M. Moyé, University at Montpellier, France; an illustrated article on the same subject by the editor; 'The Propagation of the Tidal Wave,' by Dr. T. J. J. See; 'The Planet Jupiter,' by G. W. Hough, and an obituary

notice of 'Piazzi Smyth,' by Ralph Copeland. Notes as usual are published on variable stars, planets and current spectroscopic work.

DISCUSSION AND CORRESPONDENCE.

NOTE ON THE SILURO-DEVONIC BOUNDARY.

In the recently published bulletin of the U. S. Geological Survey, No. 165, entitled 'Contributions to the Geology of Maine,' Professor H. S. Williams has again defined his attitude on the question of the Siluro-Devonic boundary in America. Here the critical argument advanced with some emphasis for the construction of the Helderbergian as a Siluric fauna is given in the following words (p. 25):

"The boundary between the Silurian and Devonian systems was first made in the Welsh series, in which the transition was from calcareous sedimentation, with rich and purely marine faunas, into sandstones of great thickness containing land plants and fishes whose habitat was, presumably, fresh or brackish waters.

"The New York section, from the Lower Helderberg limestones through the Oriskany, Cauda-galli, and Schoharie grits back again into limestones, does not pass out of marine conditions. In the Gaspé region, however, there is a complete change (as there was on the other side of the Atlantic Basin) at the point where the Oriskany fauna was evolved. [Note A.] In these Silurian faunas of the eastern province there is also much closer resemblance to the Wenlock-Ludlow series than is found in the faunas of the Appalachian province in New York. The correlation of the passage beds at the top of the Silurian of Wales is clearly to be recognized in the passage from the limestones to the Gaspé sandstones of the eastern province of America. This Gaspé transition is also to be traced with precision to the horizon of the introduction of the Oriskany fauna into the basins farther west and southwest, in which no direct passage into Old Red sandstone condition is apparent.

"We have thus in America a means of determining where the Silurian boundary belongs in purely marine series of beds and among marine faunas of unbroken succession. The Lower Helderberg in the interior of the American continent, as the Koniprusien F_2 fauna in the Bohemian Basin of Europe, is closely related in its species to what succeeds, because there was no radical disturbance of the conditions of marine life. Nevertheless, it is not the Lower Helderberg species that mark the conditions corresponding to the beginning of the Old Red sandstone; but the changes which that fauna suffered during the passage into the Oriskany time are evidences of a general disturbance which resulted in the lifting of large areas of marine surface above the level of the sea." [Note B.]

Note A.—This statement is wholly inaccurate. In the Gaspé limestones the Oriskany fauna manifests itself pronouncedly with *Hipparionyx proximus*, *Rensselæria ovoides*, *Megalanteris*, *Camarotœchia pliopleura*, *Rhipdomella*, cf. *musculosa*, *Meristella* cf. *lata*, etc., at the base of Logan's limestone No. 8, and above this horizon is the great thickness of 500–600 feet of pure limestone beds with chert bands, surprisingly similar in lithologic aspect to the gray and chocolate-colored Onondaga limestones of New York, and throughout these beds such Oriskany species are found in association with a profusion of others not represented in the interior basin Oriskany and many of them closely comparable to species of the Helderbergian. The plane of reappearance of certain Oriskany species in the Gaspé sandstone above, was shown by Logan to be 1100 feet above the top of these limestones and to be restricted to a comparatively slight vertical range. The fossils of the sandstone are not abundant nor is the fauna diversified. To any one studying these relations on the ground it is clear that they represent a brief return of the fauna of the limestone with evidences of progression and the further intermixture of species from the interior province (*Rensselæria* cf. *ovoides*, *Chonostrophia dawsoni* and *Chonetes melonica* (both of the latter in the New York Oriskany), *Leptostrophia blainvilli*, cf. Oriskany species, *Orthothetes becraftensis*, *Phacops* probably identical with *P. anceps*). The evidence from the Gaspé series is potent and conclusive that the introduction of the Oriskany fauna was accompanied by the deposition of pure calcareous sediments which were continued for a protracted period and nearly equal in actual thickness, the sum total of the Helderbergian and Onondaga limestones in the New York area of the interior basin. The species cited are in themselves evidence of the wide transgression during Oriskany time which is especially noticeable in the distribution of the sediment in New York. No tectonic change disturbs the succession in the 2000 feet of Gaspé limestones.

The fauna alone shows that during the earlier part of the period of their deposition the eastern province was more completely secluded from the interior sea than during its later stages. The Canadian geologists have expressed the probability that the 7000 feet of arenaceous sediments comprising the Gaspé sandstone may represent the major part of all subsequent Devonic deposition in that region.

Note B.—The fauna of the Helderbergian passes upward into the deposits of the Oriskany without abrupt or profound change. Its species perdure, but progress and definition are evinced in the later fauna by the introduction of many distinct types.

The prevailing conception of the Oriskany as a purely arenaceous deposit and which figures largely throughout this argument is one which needs readjustment. The normal fauna of the Oriskany of New York is that of the calcareous beds of the eastern part of the basin. These beds always contain a considerable content of silica in the form of sand, but they are clearly the deeper water deposits of which the sandstone beds of the typical Oriskany section and the intermediate thin bands of altered sandstone (quartzite) are the shallow water shore-line deposits. The sandy layers of the Oriskany only share the fauna of the calcareous beds, and it is quite clear that their species have been derived from the deeper water centers of dispersion largely through mechanical agency. It is therefore not competent to argue a lower calcareous Oriskany and an upper arenaceous Oriskany, as, in New York, at least, there is but one Oriskany fauna, and the formation is not divisible into facies except geographically.

The foregoing notes indicate that the argument cited is built upon the sand. Nevertheless it is throughout that which served de Verneuil and Murchison above fifty years ago and through that agency produced its effect upon Hall's correlation of the Oriskany and Lower Helderberg. It is that argument too with no additions, summed up in the statement that Siluric time was closed with a general world-wide crustal elevation initiating rapid base-leveling and the accumulation of sandy deposits at the opening of the Devonic in all countries. To the recrudescence of this ancient doctrine the labors of Kayser, Frech, Tschernyschew and other European geologists upon the calcareous facies of the earliest Devonian in the Harz, Westphalia, Bohemia and the Urals afford no balm. The old hypothesis of cycles of sedimentation loses force when applied simultaneously to every part of the earth's surface, and cycles of sedimentation are not a basis of geologic classification save as some element therein indicates widespread orographic derangement. The argument as here constructed seems to be as follows: The grand event which terminated the Siluric was the universal elevation of the land, the erosion of which supplied the materials for the sandy sediments of the opening stages of the Devonic. This opening Devonic stage in the marine succession is impregnated with species of Oriskany type; 'the Lower Helderberg is therefore proven to belong to the typical Silurian system of the American Continent' (*op. cit.*, p. 26). Both premises limp and the conclusion falls. The deposition of sandy sediment was not contemporaneous in the early Devonic, but, however widespread, it may have been upon the epicontinental plateau, calcareous sediments of contemporary origin must have been present in the greater and less disturbed depths, retaining some of the pre-existing types, but showing freely the progressed and differentiated types of the new era. These relations of coeval faunas can be determined only upon the most careful analysis of organic content, and such analysis has cogently shown the intimate affinity of the Helderbergian with the calcareous Oriskany of which it is the immediate and purest calcareous predecessor in the vertical series. As in the Gaspé succession, so in New York, the species of Helderbergian time, notably unlike in the two separated provinces, pass, in each, into association with those of the Oriskany when by transgressing sedimentation and freer intercourse between the provinces a consequent commonalty of species was effected.

The succession in the Gaspé peninsula like that of the basins of Bohemia and the Urals again declares the ultimate and final authority of the fauna, its variations, progression and

specialization, in pronouncing upon a critical question in the classification of the fossiliferous rocks.

John M. Clarke.

THE PROBLEM OF COLOR.

Although I don't accept Professor Cattell's contention, in the last number of the *Psychological Review*, that the nugatory process by which two colored lights (if properly chosen in hue and in intensity) disappear for sensation and leave behind a sense of grayness only is due to a cortical and not to a retinal physiological process, I am nevertheless willing (in the interest of fair play) to furnish him with one more reason on his side. When a colored object is mirrored in a piece of colored glass (say red in blue), we get in general a color blend, that is, for consciousness, a reddish-blue sensation. In case the colors chosen are a pair which, on fusing, are transformed into something else (yellow and blue into white, or red and green into yellow), this is, according to all the non-psychical color-theories, because two counteracting color-processes in the retina are exactly balanced, or else because two partial photo-chemical molecular dissociations unite to complete each other and to produce an undifferentiated gray-process,—either of these suppositions being sufficiently plausible in itself. But—and this is the fact, if it is a fact, which works upon Professor Cattell's side—there are occasions upon which, according to Helmholtz and to Wundt, this antagonism, or this completion, fails to take place. One sometimes sees, they say, one color *through* the other; guided by the belief that the red sensation is due to the presence of a red book, *e. g.*, one cannot help but *see* the redness of the book through the sea of blue. They do not dwell upon the colors which they used in making the experiment—so long as these are red and blue there is nothing strange in the differing interpretations; but if, under these circumstances, blue and yellow should not give white (and red and green should not give yellow), then it would seem to follow that the antagonistic or the completing processes are not of the nature of chemical changes in the retina—such could not be so easily undone by the reasoning, or the perceiving, Psyche. Hering denies with great warmth the contention of Helmholtz and of Wundt that these exceptional cases occur; or rather, he says that if they do occur it is owing to spots or unevennesses in one or the other of the two surfaces. But even though she be assisted by any ulterior aids whatever, it would not seem that the Psyche can undo, in the interests of reasonable interpretation, a chemical change that has already taken place. Perhaps she can, however; but in that case her powers must also suffice to undo an *actual* white (or yellow) and separate it into its possible components. If, in the case of a blue book seen in a yellow glass, for a portion in the center of the surface of the book a gray of equal brightness be substituted, and a like gray for an exactly coinciding portion of the yellow reflector, then it is possible that self-deception would go so far as to enable us to see a continuous blue book in a continuous yellow mirror. The experiment is perhaps worth trying.

On the other hand (to be equally fair to my own side, in turn), the fact that *binocular* color mixture does not occur to any great extent—that is, does not occur for colors far apart in the spectrum—is at once destructive to any hypothesis which relegates the fusion of colors to the perception-forming centers of the brain. Whether an overlapping blue and yellow are mediated by one eye or by two can have nothing to do with the case if their mutual quenching is an affair of perception. Helmholtz, after a long series of the most painstaking experiments, declared absolutely that binocular color-fusion does not take place.* This shows, in passing, the unprejudiced character of his work, for the fact, as I have said, is quite destructive to his theory that the mutual suppression of blue and yellow into white is merely a matter of the judgment: it cannot make any difference whether we know that we see blue and yellow at once through one nasal half-retina, or through a nasal and a temporal half-retina together—the more so as we have in general

* Binocular color-fusing of two complementary colors many be obtained with the Hering color-mixer by 'long and steady gazing,' but this is the sufficient condition for turning each color into a dead gray, when looked at by itself.

absolutely no consciousness as to which eye we are seeing anything with.

It is customary to speak of color-mixing as if it were the same sort of thing throughout the whole spectrum, but in reality it is of two very different kinds. When a unitary green and blue are mixed to produce a blue-green, the phenomenon is purely a psychological one (and there is nothing strange in the fact that such mixtures work binocularly as well as monocularly); we can see in the blue-green the blue and the green of which it is composed (and we have not even in this case taken the trouble to devise a separate name for it). But if a spectral red and a spectral green in neither of which any trace of yellow can be detected be seen together (and even if one of them is a trifle bluish), a yellow is produced which has not any perceptible falling off, even in saturation, from the yellow of the spectrum (as has just been stated explicitly by Breuer and von Kries); and a correspondingly strange event results from the mixing of blue and yellow. To say that such a transformation-scene as this is the work of judgment (the judgment being led to it by no motive whatever—it cannot be anything in reality, it would seem, but the pure spontaneous play of fancy, rather than the work of a reasons-obeying judgment, or perception)—this is to make a serious draft upon the powers with which we need to endue that faculty, or, to use the more modern term, that cortical center. At all events, the two occurrences are very different, and my object now is merely to suggest that they should be called by different names. When green and yellow producing ether-radiations are thrown together upon the retina, I would propose that the yellow-green sensation which results, be called a *color-blend*, and that the two colors be said to be blended. But when yellow and blue unite to make gray, I should say, using in fact a term of Helmholtz's, that the process is one of mutual *color-quenching* (and in the same way red and green may be said to quench each other when they result in yellow). Color-blending is plainly a psychological matter; color-quenching it is far more natural, in the first instance, to attribute to a peculiarity of the photo-chemical processes which we know to be going on in the retina.

Farther—still in the interest of mutual comprehensibility between the adherents of different schools, who speak at present languages which have too little in common—I would propose to call red, yellow, blue, and green, not primary, nor elementary, nor fundamental colors—that commits one to one or other of the rival schools; not 'principal' colors—that is purely an æsthetic designation; but *unitary* colors. Since the admirable discussion of this subject by Professor Elias Müller (*Ztsch. f. Psychol.*, Vols. X. and XIV.) no one can doubt—even of those who doubted it before—that these particular ether-radiations have for consciousness a peculiar character—that of being the end-members of 'rectilinear' color-series (series such that each member differs from the one before it *in the same way* in which that differs from the one next preceding); in other words, they are not, for consciousness, of the nature of *color-blends*. Yellow-green and green-blue are—on their faces—color-blends. Orange and violet have secured unitary names for themselves (though they are nothing but a reddish yellow and a reddish blue)—doubtless on account of the excessive interest which attaches to reds in nature as compared with greens; but that is not sufficient to make them unitary colors. This nomenclature commits one to no theory whatever—whether retinal or cortical; it is simply the expression of the psychological fact that there are four very characteristic points in the color gamut, red, yellow, green and blue, their character being sufficiently described by the word *unitary*. That this is true will easily be seen by any one who will take the trouble to spread out for himself in order in a circle as many different color-hues (all of the same saturation and the same brightness—the spectrum will not do, therefore), as can be procured.

To conclude, a color-blend is then surely a psychological product; an instance of color-quenching is either psychical or physiological according to the theory which one is pleased to adopt. How hard it is for the physicists to understand this point of view is evidenced by the fact that they are constantly affirming that fresh proof has been adduced of the Young-Helmholtz theory, because it has been shown that all the colors of the rainbow and white

besides can be made out of the *physical* mixture of red and green and blue. That fact has been put beyond doubt, once for all, by the exceedingly exact measurements of Professor König, made by means of an instrument of very ingenious construction (and so expensive that it has been duplicated for hardly any other laboratories). There is not a psychologist who denies this physical fact, and for the physicist to constantly re-affirm it, and to say that it has received fresh proof (see the report of the last meeting of the scientific societies in New York) is much the same as if he should valiantly affirm that one side of a shield is of silver by way of opposition to those who say that the other side is of gold. What the psychologist denies is not that gray results when blue and yellow are mixed upon the color wheel—he has admitted that long ago, and it will be found as an elementary statement in every text-book of psychology. But he refuses to admit, nevertheless, that white is an even red-green-blue *sensation* in the same sense in which purple is an even red-blue sensation. It is here that the adherents of the Young–Helmholtz theory should attack him.

C. Ladd Franklin.

A LARGE CRYSTAL OF SPODUMENE.

To the Editor of Science: There has recently appeared in some scientific journals a notice of a crystal of spodumene stated to be about twenty-nine feet long, and to be the largest known. It may be of interest to your readers to learn that a much larger crystal has been observed. In the year 1885 while studying the tin ore or cassiterite localities of the Black Hills of Dakota I saw and measured, in the Etta tin mine near Harney's Peak, a spodumene crystal thirty-eight feet and six inches in length and thirty-two inches in thickness. This thirty-eight and a half foot crystal was almost perfect, and was situated within a few yards of the surface. Owing to its size and the difficulties of transportation at that time, the railway being one hundred and thirty miles distant, I made no attempt to have the crystal removed. I, however, collected other crystals of spodumene in the vicinity, and some of these measured from two to six feet in length. Subsequently, in a public lecture upon the Black Hills, given in the University of North Dakota in February, 1886, I announced the discovery of the aforesaid gigantic crystal; but, because of the pressure of teaching and other numerous duties, that discovery has not been reported in the regular scientific journals.

For the benefit of some readers it may perhaps be well to state that spodumene is a grayish-white or pink mineral of considerable hardness, being nearly as hard as quartz, and that it consists of silica, alumina and lithium.

Henry Montgomery.

Trinity University, Toronto,
July 17, 1900.

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*UNITS AT THE INTERNATIONAL ELECTRICAL CONGRESS.**

At the suggestion of Professor Hospitalier, Section I. of the Congress agreed that the following should be the members of the Commission on Units: Messrs. Ayrton (Great Britain), De Chatelain (Russia), Dorn (Germany), De Fodor (Hungary), Eric Gérard (Belgium), Hospitalier (France), Lombardi (Italy), Kennelly (United States); and at the first meeting of the Commission, on August 21st, which was attended also by Professor F. Kohlrausch and Sir W. Preece—whose names had been added to the list of the government delegates for Germany and England—a report presented to the Congress by the American Institute of Electrical Engineers was taken into consideration. This report had been drawn up for that Institute by a committee appointed for this purpose, and it contained the following resolutions:

(1) We consider that it is necessary to give names to the absolute units in the electromagnetic and electrostatic systems, as well as convenient prefixes to designate the decimal multiples and submultiples of these units in addition to those already in use.

(2) The International Congress of Electricians, which will take place this year in Paris, should be invited to choose the names and the prefixes.

(3) A great advantage would be gained by a rationalization of the electric and magnetic

*From *Nature*.

units, and the Congress should be invited to find ways and means to obtain such a rationalization.

The proposition to rationalize the units—that is, to change them so that the coefficient 4π should not appear—was withdrawn by Dr. Kennelly on behalf of the United States; as well as the suggestion regarding the employment of prefixes, and it was resolved that:

The Commission will only deal with propositions that will introduce no change in the decisions arrived at at previous congresses.

A long discussion then took place as to whether it was really necessary to give names to the C. G. S. units either in the electrostatic or the electromagnetic systems, and finally it was agreed to withdraw the proposition so far as it dealt with the electrostatic system.

The desirability of giving a name to the unit of magnetic field and to the unit magnetic flux was strongly urged, and as the names of *Gauss* and *Weber* had been employed for some years in America for these units respectively, the advantage of adopting these names for the C. G. S. units of field and flux was advocated. On the other hand, the resolution arrived at by the Electrical Standards Committee of the British Association in 1895 to employ those names respectively for other units was pointed out. Finally, the Commission, at the end of their second sitting, on August 22d, recommended the following:—

"The Commission is not of opinion that it is necessary to give names to all the electromagnetic units.

"However, in view of the use already of practical instruments which give the strength of a magnetic field directly to C. G. S. units, the Commission recommends that the name of *Gauss* be assigned to this unit in the C. G. S. system.

"The Commission proposes to assign to the unit of magnetic flux, of which the magnitude will be subsequently defined, the name of *Maxwell.*"

These resolutions were brought before Section I. of the Congress on August 24th, and led to a long discussion. M. Mascart opposed the giving a name to the C. G. S. unit of magnetic field. The employment of practical instruments for the direct measurement of the strength of magnetic fields in C. G. S. units was not, in his opinion, a sufficient reason for assigning a name to that unit. Besides, this decision of the Commission appeared to be contrary to the spirit of the Congresses of 1881 and 1889, which did not give the names of men to the C. G. S. units. He admitted that the name of a man might be given to the practical unit. In any case the name of 'Gauss' seemed to him liable to give rise to confusion, for Gauss was the originator of the first absolute system employed, viz, that of the 'millimetre-milligramme-second' system, and that system, as distinguished from the 'centimetre-gramme-second' system, was still in actual use in certain cases—for the measurement of the earth's field, for example.

Professor Kohlrausch said that the 'absolute units' were enough for the physicists, but that, if the engineers felt the need of practical units, Dr. Dorn and he did not see that any inconvenience would arise from names being given to them, such as those of Gauss and of Maxwell, for example. The German delegates could not, however, commit their Government in the matter, and they considered that the Congress should limit its recommendations to the use of these new names without seeking that legal sanction should be given to them.

Professor Ayrton agreed with M. Mascart, and mentioned that during the past five years many 'Ayrton-Mather Field Testers' had been constructed to read off the strength of a magnetic field directly in C. G. S. units, but that no need for any special name for that unit had been felt in connection therewith. He added, however, that, while holding the opinion expressed by M. Mascart that it was not desirable to give the names of persons to the C. G. S. units, the units of field and flux had this peculiarity, that without any multipliers they were the practical units adopted.

To this M. Mascart replied that the word 'practical' in this connection was ambiguous, since, although it was true that the C. G. S. units of magnetic field and flux were employed in practice, they did not belong to the so-called 'practical system.'

M. Hospitalier appealed to the Section to give names to the unit of field and the unit of flux. He did not ask for any legal decision in

the matter, for the names were put forward as a simple recommendation to the Section.

After a discussion in which Messrs. Ayrton, Carpentier, Dorn, Hospitalier, Kohlrausch, Mailloux, Mascart, A. Siemens, Silvanus, Thompson and others took part, Professor Eric Gérard stated that in his opinion it was desirable to come first to a decision that names should be given to the C. G. S. units of magnetic field and to flux of magnetic induction.

M. Mascart, expressing his approbation of this idea, the president of the Section, M. Violle, put the following proposition formally to the meeting:

"The Section reeommends the adoption of specific names for the C. G. S. units of magnetic field and of magnetic flux." This proposition being adopted, with only two dissentients, the meeting was adjourned for a short time to enable the members to exchange their views regarding the exact names that should be employed. On the meeting reassembling, the president put the two following propositions successively:

(1) *The Section recommends the adoption of the name of* GAUSS *for the C. G. S. unit of magnetic field.*

(2) *The Section recommends the adoption of the name of* MAXWELL *for the C. G. S. unit of magnetic flux,*

both of which were adopted with only two dissentients.

On the same afternoon these resolutions of Section I. were submitted to the Chamber of Government Delegates to the Congress and adopted, and finally, at the closing meeting of the Congress on Saturday, August 25th, the action which had been taken in the matter was formally reported by M. Paul Janet, one of the two secretaries of the Congress.

THE PROPOSED NATIONAL STANDARDS BUREAU.

THE American Philosophical Society has adopted the following resolution in regard to the proposed National Standards Bureau:

Whereas, In the conduct of accurate scientific investigations, the use of apparatus of guaranteed accuracy is a need recognized by all scientists; and

Whereas, In foreign countries, notably in Germany, in France, and in England, such guarantee is furnished by standardizing bureaux under the control of the respective governments; and

Whereas, At present the United States Office of Standard Weights and Measures does not possess appliances necessary for this verification of as wide a range of apparatus as seems essential, nor the working force required to comply with legitimate demands for the verification and stamping of the various scientific apparatus designed for measurements of precision, thus compelling the importation of foreign-made articles when such official certification is desired; and

Whereas, This state of affairs is not only unsatisfactory to all investigators in both pure and applied science, but also works injustice to our manufacturers of nearly all physical and chemical apparatus designed for accurate measurement, who cannot supply the proper certification with such instruments: therefore be it

Resolved, That the Congress of the United States be urged to establish a National Standards Bureau, in connection with the U. S. Office of Standard Weights and Measures, which shall provide adequate facilities for making such verification of scientific measuring apparatus and stamping the same as are provided by foreign governments for similar work.

Resolved, further, that a copy of the foregoing be forwarded to the Secretary of the Treasury, under whose control the present office of Standard Weights and Measures comes; to the Superintendent of the U. S. Coast and Geodetic Survey; to the President of the U. S. Senate; to the Speaker of the United States House of Representatives; to the Chairman and members of the Committee on Coinage, Weights and Measures, and to any other officials or individuals likely to be interested or influential, with a request for their co-operation in our efforts to secure for the U. S. Office of Standard Weights and Measures ample facilities, in point of apparatus and working force, to enable that office to comply with the requests for the verification of measuring instruments that may be made by American scientific workers.

SCIENTIFIC NOTES AND NEWS.

DR. WILLIAM T. HARRIS, United States Commissioner of Education, has been awarded the grand prize of the Paris Exposition.

MM. LACAZE DUTHIERS and E. Mascart have been made grand officers of the French legion of honor, and MM. Henri Moissan and Troost are among those who have been made commanders. A large number of scientific men have been made officers and knights. These decorations have been conferred on the occasion of the Paris Exposition.

PROFESSOR LAMP, astronomer at the Kiel Observatory, will be absent for two years on an expedition to South Africa to determine the boundary between German East Africa and the Congo Free State.

PROFESSOR W. J. SIMPSON and Colonel Notter have gone to South Africa to investigate dysentery and enteric fever. Before leaving England they were inoculated against typhoid fever by Professor Wright.

THE Göttingen Society of Sciences has made the following awards: To Professor F. Klein 800 Marks for the Mathematical Encyclopædia and 500 Marks for the preparation of kinematic models, and 500 Marks to Professor Wiechert for the construction of seismological recording instruments.

FOLLOWING the banquet given to Lord Lister by the Paris Scientia Club a banquet was given to Lord Kelvin at which M. Oliver presided and speeches were made by MM. Mascart and Cornu to which Lord Kelvin replied.

PROFESSOR GIARD, director of the biological station at Wimereux, has been elected Knight of the Order of Leopold by the Belgian government.

IT is stated in *Nature* that Professor J. C. Bose, who has been attending the recent International Congress of Physics at Paris as the delegate of the Government of Bengal, proposed to attend the British Association meeting at Bradford in the same capacity, and would there describe some electrical investigations with which he has lately been engaged.

SIR W. MCGREGOR, M.D., C.B., Governor of Lagos, will deliver the opening address at the London School of Tropical Medicine in October.

DR. DOMINGO FRAIRE known for his work on the yellow fever bacillus has died at Rio Janeiro, at the age of 50 years.

UNDER the auspices of the Ottawa Field-Naturalists' Club last fall a movement was inaugurated with the object of perpetuating, in some visible and tangible manner, the memory of Elkanah Billings, who died some 24 years ago. He conducted the *Canadian Naturalist and Geologist* for several years, first in Ottawa, but later in Montreal, whither Sir William Logan had induced him to go and join him in investigating the geological resources of old Canada (Quebec and Ontario). For twenty years Mr. Billings labored in the Survey, and by his good work achieved reputation as a paleontologist and a geologist. The memorial will take the form of a portrait painted by Mr. Charles E. Moss, which will be presented to the Geological Survey Department and placed in the museum near the collections made by Billings. Subscriptions towards the memorial may be sent to Dr. H. M. Ami, Geological Survey Department, Ottawa, Can.

THE International Congress of Hygiene was held in Paris from August 10th–17th with more than 1600 members in attendance. Professor Brouardel, dean of the faculty of medicine in Paris, presided, with honorary presidents from the different nations as follows: Dr. Calleja (Spain), Dr. Köhler (Germany), Dr. Pagliani (Italy), Professor Corfield (Great Britain), Dr. Van Trama-Sternegg (Austria), Dr. Bartolette (United States), Dr. Borup (Denmark). The Congress met in nine sections to which over fifty reports were presented for discussion.

THE fourteenth International Medical Congress will be held at Madrid during the spring of 1903 and will be under the presidency of Professor Julien Calleja, dean of the Faculty of Medicine.

THE twelfth International Congress of Anthropology and Historic Archæology opened at Paris on August 20th under the presidency of M. Bertrand.

THE next international Congress of Mathematicians will be held in Germany in the summer of 1904. The place has not yet been definitely decided upon.

THE Royal Saxon Antiquarian Society of Dresden celebrated its seventy-fifth anniversary on September 26th.

A PASTEUR Institute has been opened at Kasauli, a hill station in the Punjab district of India, about thirty miles from Simla.

THE University of Aberdeen has received from Miss Cruikshank botanical gardens, 6 acres in extent, with an endowment of £15,000. The gift is made in memory of her brother Dr. Alexander Cruikshank.

THE *Botanical Gazette* states that the private herbarium of Harry N. Patterson, of Oquawka, Illinois, containing about 30,000 sheets, has been secured by the Field Columbian Museum, and will be installed with the rapidly growing collections of that institution as promptly as the careful cataloguing practiced in all departments will admit. The botanical department of the museum is to be congratulated upon this accession of one of the notable private herbaria of the country; one that will add a complete collection of Pringle's Mexican plants to its already excellent representation of the flora of that region and the Antillean islands. Mr. Patterson's herbarium is more or less contemporaneous with that of the late Mr. Bebb which the museum secured some three years ago, and as Mr. Patterson made it his aim to secure a complete series of the species of North America, its addition to the collections of the museum will be of great value to botanical students and specialists in the west.

DR. L. A. BAUER, in charge of the magnetic work of the U. S. Coast and Geodetic Survey, has left Washington for a three month's trip to Alaska and the Hawaiian Islands, in order to select the sites for the magnetic observatories in those regions. A third magnetic observatory, known as the Principal Magnetic Base Station, is now being built sixteen miles southeast of Washington, D. C., and a fourth observatory is at present in operation at Baldwin, Kansas, centrally situated to the area now being surveyed by the various magnetic parties. The last named observatory will be shifted about in the western states according to the requirements of the magnetic survey. It is the intention to have the four observatories ready in time to co-operate with the various antarctic expeditions.

DRS. L. DIEHLS and E. Pritzel have undertaken a botanical expedition to Australia on behalf of the Berlin Museum. They will explore the little known western parts of Australia. Also in the interests of the Berlin Museum Dr. Ule has gone to the sources of the Amazon to make botanical collections and especially to study the gutta-percha plant.

MR. GEORGE VANDERBILT is defraying the expenses of an expedition to Java by Mr. David J. Walters of New Haven, who proposes to search for remains of *Pithecanthropus erectus*.

THE daily papers report that the *Stella Polaris* with the Duke of Abruzzi and his party has returned to Norway from the Polar regions. The steamship lay for eleven months in the ice in latitude 82°, but several parties proceeded further with sleighs and Captain Caigni, who was gone 104 days, reached latitude of 86° 33′, a little further than the point reached by Nansen in 1895. The Duke of Abruzzi was himself disabled by having two fingers frostbitten, and did not take part in the expeditions. The party appears to have suffered a good many hardships. No report has yet been received that throws any light on the possible value of the scientific results of the expedition.

In connection with the meeting of the German Colonial Society at Coblentz a prize of 3000 Marks is offered for first finding gutta-percha plants in the German colonies and transplanting them to one of the experimental stations or to the central station in Berlin.

THE National Educational Association offers prizes as follows: For the best essay submitted on each of the following topics: the seating, the lighting, the heating, and the ventilating of school buildings, $200; for the second best essay submitted on each topic, $100. Each essay shall be limited to ten thousand words and shall be submitted in printed or typewritten copy without signature, but with name of the author enclosed with it in a sealed envelope. Three copies of each essay shall be submitted, and addressed to the chairman of the committee, Mr. A. R. Taylor, at Emporia, Kansas. They must be mailed not later than February 1, 1901.

THE Magellanic gold medal of the American Philosophical Society will be awarded in December to the author of the best discovery or of the most useful invention in the physical sciences presented to the Society before November 1st.

MR. J. H. PORTER, of London, has just issued the final part of Messrs. Sclater and Thomas' 'Book of Antelopes,' which completes this important zoological work. It was planned by the late Sir Victor Brooke (to whose memory it is dedicated), and most of the plates were drawn under his superintendence more than twenty years ago. After Sir Victor's death, in 1891, the present authors undertook to prepare the letter press. The four volumes of the 'Book of Antelopes' contain 100 colored plates and 121 illustrations in the text.

MR. HEINEMANN will bring out in the autumn an account of the Antarctic expedition of the *Belgica*, written by the only English-speaking member of her crew, Mr. Frederick A. Cook, who accompanied the expedition as surgeon, anthropologist and photographer.

THE Philosophical Society of the University of Vienna proposes to publish a complete catalogue of psychological literature published between 1850 and 1900.

THE Journal officiel of the Paris Exposition has published in a number containing 350 pages the list of awards made at the Paris Exposition. There were in all 75,531 exhibitors of whom 42,790 received awards. The number of each kind of prize awarded is given in the first column of the accompanying table, while in the second column is the number conferred on Americans.

Grand Prize	2,827	218
Gold Medal	8,166	486
Silver Medal	12,244	583
Bronze Medal	11,615	423
Honorable Mention	7,938	270

In the Department of Education (Group I.) 12 grand prizes were awarded to the United States for primary education, 9 for secondary education, 13 for higher education, one for agricultural education, 6 for industrial education. It is perhaps somewhat surprising that the United States should have been awarded 41 grand prizes in education, as compared with 6 in machinery and electricity.

WE announced last week the death of Dr. John Anderson and now take from the *London Times* the following facts in regard to his life: Dr. Anderson was the son of the late Mr. Thomas Anderson, secretary to the National Bank of Scotland, Edinburgh, in which city he was born in 1833. He was educated at the George-square Academy and the Hillstreet Institution, and finally at the Edinburgh University. In 1861 he took the degree of M.D. and received a gold medal for his thesis entitled 'Observations in Zoology.' Immediately after his graduation he was appointed professor of natural science in the Free Church College, Edinburgh, but he resigned the office in 1864, having been offered the curatorship of a museum which the Government of India intended to found in Calcutta, and of which the collections of the Asiatic Society of Bengal were to form the nucleus. He arrived in India in July, 1864, and in the following year was appointed superintendent of the Indian Museum. Two or three years afterwards he was also given the chair of comparative anatomy in the Medical College, Calcutta. In 1868 he was selected by the Government of India to accompany an expedition to Western China *via* British and Independent Burma, in the capacity of scientific officer. Again, in 1874, he was chosen by the Government of India to proceed once more to Western China in the same capacity as on the former expedition, and with instructions to advance from Bhamo to Shanghai. This expedition was attacked by the Chinese, and was obliged to retreat to Burma. In 1881 Dr. Anderson was sent by the trustees of the Indian Museum, Calcutta, to investigate the marine zoology of the Mergui Archipelago, off the coast of Tenasserim. In 1887 he retired from the service of the government of India. Besides numerous papers on zoology, Dr. Anderson is the author of many independent works, among them being 'A Report on the Expedition to Western China *via* Bhamo,' published by the government of India in 1871; 'Mandalay to Momien,' an account of the two expeditions to Western China under Colonel Sir Edward Sladen and Colonel Horace Browne;

'Anatomical and Zoological Researches,' including an account of the zoological results of the two expeditions to Western China in 1868–69 and 1875. The scientific results of his researches in the Mergui Archipelago were published by the Linnean Society of London, and he also published in 1890 an account of 'English Intercourse with Siam in the Seventeenth Century,' as one of Trübner's Oriental Series. In addition to being a fellow of many learned societies he was also a Fellow of the Calcutta University and a corresponding Fellow of the Ethnological Society of Italy. In 1885 the University of Edinburgh conferred on him the honorary degree of LL.D. In 1896 Dr. Anderson published a small volume on 'The Herpetology of Arabia,' and he was lately engaged on a work dealing with 'The Fauna of Egypt.'

UNIVERSITY AND EDUCATIONAL NEWS.

HARVARD UNIVERSITY, Radcliffe College and the Massachusetts Institute of Technology each receive $2000 by the will of Barthold Schlesinger, of Brookline, Mass.

MR. JOHN D. ROCKEFELLER has given $180,000 to Spellman Seminary, a Baptist college for negroes at Atlanta, Ga.

THE Corporation of Harvard University has passed the following minute in acknowledgment of the gift of $100,000 made through Mr. Alexander Agassiz from Mr. and Mrs. Quincy A. Shaw, Mrs. Henry L. Higginson and himself for the immediate construction of the southwest corner of the Oxford street façade of the University Museum: *Voted* that the president and fellows gratefully accept this large gift on the terms and conditions named in Mr. Agassiz's letter, and hereby record their sense of the great worth of a gift which strengthens and perpetuates the precious associations with the name of Agassiz at Harvard University, and perfectly illustrates the noble use of private wealth for the promotion of public intellectual ends.

THE city of Lafayette, Ind., has presented to Purdue University a 2,000,000-gallon water works pumping engine for use in the laboratory of the university. It was built in 1875 and is an excellent example of the duplex walking-beam pump. In addition to its historical value it will furnish an ample supply of water for the hydraulic experiments which will be carried on.

SMITH COLLEGE will celebrate the 25th anniversary of its foundation on October 2d and 3d. On the latter day historical addresses will be made by the Rev. Dr. John M. Greene, and President Seelye, and there will be an educational conference, with addresses by Dr. William T. Harris, United States Commissioner of Education; Dean Le Baron Russell Briggs, of Harvard University; President Arthur M. Hadley, of Yale University; President Seth Low, of Columbia University; President James M. Taylor, of Vassar College; President Caroline Hazard, of Wellesley College, and President M. Carey Thomas, of Bryn Mawr College.

PROFESSOR J. G. MCGREGOR, of Dalhousie University, Halifax (N. S.), has been appointed professor of physics in the University College, Liverpool, in succession to Professor Lodge.

DR. F. E. BOLTON, of the Milwaukee State Normal School, has been elected professor of pedagogy in the State University of Iowa.

DR. WALTER FRANCIS WILCOX has been appointed lecturer on the United States Census of 1900, at Harvard University.

PROFESSOR RUSH RHEES, the new president of the University of Rochester, is to be formally installed on Oct. 11th.

THE Crown appointments on the Senate of the University of London are: Sir John Wolfe-Barry, Sir Henry Roscoe, Mrs. Henry Sidgwick, and the Hon. W. Pember Reeves, and, as a representative of the faculty of laws, Lord Davey.

DR. ADOLF SAUER, associate professor at Heidelberg, has been elected professor of mineralogy and geology and director of the newly established geological bureau at Stuttgart.

DR. TCHERMACK, docent at Leipzig, has been appointed assistant in the physiological laboratory at Halle.

DR. ABEGG, docent in chemistry at Breslau, has been promoted to an associate professorship. At the same university Dr. Emil Bose has qualified as docent in physics.